RESEARCH DEPARTMENT

Buzz on sound in 625-line television reception

TECHNOLOGICAL REPORT No. RA-8

UDC 621. 391. 827. 4 : 621. 397. 62
1967/41

THE BRITISH BROADCASTING CORPORATION
ENGINEERING DIVISION

RESEARCH DEPARTMENT

BUZZ ON SOUND IN 625-LINE TELEVISION RECEPTION

Technological Report No. RA-8
UDC 621.391.827.4: 1967/41
621.397.62

G.J. Phillips, M.A., Ph.D., B.Sc., M.I.E.E.
J.D. Lunn, B.Sc.

D. Maurice

for Head of Research Department

This Report is the property of the British Broadcasting Corporation and may not be reproduced or disclosed to a third party in any form without the written permission of the Corporation.

This Report uses SI units in accordance with B.S. document PD 5686.

Technological Report No. RA-8

BUZZ ON SOUND IN 625-LINE TELEVISION RECEPTION

Section Title Page

SUMMARY 1

1. INTRODUCTION 1

2. TRANSMITTER OVERMODULATION 1

3. TESTS ON RECEIVERS 1

3.1. Measurements with a Slide 1
3.2. Other Causes of Buzz 2

4. DISCUSSION OF TESTS 3

5. CONCLUSIONS 4

September 1967

Technological Report No. RA-8
UDC 621.391.827.4: 1967/41
621.397.62

BUZZ ON SOUND IN 625-LINE TELEVISION RECEPTION

SUMMARY

This report is an attempt to put the various aspects of the buzz-on-sound problem in perspective. The principal subject of discussion is the effect of non-linearities in a receiver on the sub-harmonics of 6 MHz in the video information. Other possible causes of buzz are mentioned, and some conclusions are drawn regarding receiver design; in particular, the use of two separate diode detectors for vision and intercarrier sound signals is advocated.

1. INTRODUCTION

Shortly after the opening of BBC-2 it was found that buzz-on-sound effects occurred on many receivers when certain types of picture were transmitted. The basic cause was considered to be the presence of sub-harmonics of 6 MHz in the video modulation, and the production of sufficiently strong 6 MHz components to interfere with the 6 MHz f.m. sound signal which, in current black-and-white receivers, is extracted from the vision detector or first video stage. There are, however, a number of different factors which govern the amount of harmonic production. Research Report No. G-095 discussed one cause, namely "quadrature distortion". In this case, an envelope detector with vestigial sideband operation is capable of generating harmonics of the higher video frequencies. In some receivers video amplifier distortion also contributes, and either of these causes are enhanced if the transmitter overmodulates (i.e., if the carrier voltage at peak-white falls below 18% of the value for synchronizing pulses). Initially it was noticed that films with superimposed captions in white letters were particularly noted for buzz-on-sound effects. These captions can be produced by etching through the emulsion down to the clear base material of the film. This results in the captions being "whiter" than any other area of the picture, and overmodulation of the transmitter is possible unless careful control of the video signal amplitude is exercised. Furthermore, the amount of harmonic production needed to cause interference to sound in a given receiver depends on the level of sound carrier (relative to vision carrier) at the vision detector; the severity of buzz can also depend on the bandwidth, limiter efficiency and accuracy of alignment of the 6 MHz sound i.f. circuits and discriminator.

2. TRANSMITTER OVERMODULATION

As soon as the buzz problem was recognized, a suitable limiter for the outgoing video signal was produced by Designs Department. Tests arranged in conjunction with Chief Engineer, Television, showed that this was effective in preventing overmodulation and that it brought about an improvement. But there still remained the problem that buzz can occur on some receivers with certain picture content even though there is no overmodulation. This has been confirmed by tests on receivers in Designs Department with electronically generated patterns of vertical stripes, as reported in Designs Technical Memorandum 11.27(66), and by further tests in Research Department on six receivers of different manufacture, as reported in the following Section.

3. TESTS ON RECEIVERS

3.1. Measurements with a Slide

For laboratory tests it was decided to use a special slide in a flying-spot scanner, and the following considerations had to be taken into account:

(i) The slide should be representative of possible picture content.

(ii) Some quantitative as well as subjective information should be provided by the experiments.

After trials with various patterns, a slide with a series of vertical bars of about 1·5 MHz repetition rate and with a pulse duration of about 0·35 of the

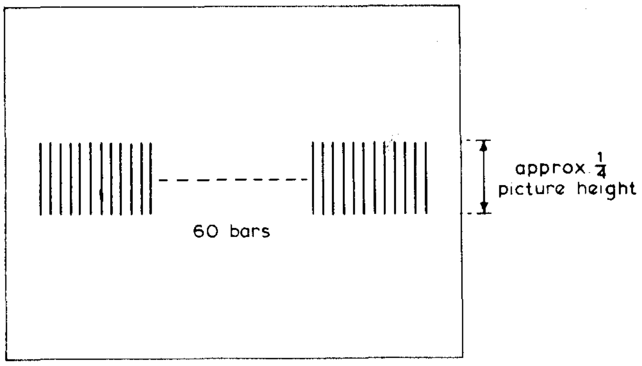

Fig. 1 - Slide used for buzz-on-sound tests

repetition period was found suitable for a simple but exacting test for sound buzz (See Fig. 1). The mark-to-space ratio of the bars in this slide is similar to that which occurs between the vertical strokes in a caption, and they cover a representative area of the whole picture. The pattern was designed, using Fourier techniques, to ensure that the bars were capable of generating sub-harmonics of 6 MHz at a reasonable amplitude, thus simulating a "worst case". Fig. 2 shows the frequency spectrum for an infinite train of these bars, values of frequency being obtained by multiplying *n* by the fundamental frequency of the bars. The slide was made with black bars, and a video inverter was used in the scanner to give white bars. This enabled a better control of the limit of modulation depth on the white bars. Adjustment of bar spacing over a limited range was possible by adjusting the amplitude of the line scan in the scanner. This adjustment of the fundamental frequency of the bars gives, in effect, a continuous variation in the frequencies of the line spectrum illustrated in Fig. 2. It was possible, therefore, to study the potential that a number of video frequencies had for the generation of buzz-on-sound effects.

Tests were carried out with six commercial receivers. Throughout the experiment the signal fed to each receiver conformed to the accepted U.K. 625-line standard. The white level was set at 20% carrier (ref. peak sync. carrier level), and the vision-to-sound carrier ratio was carefully maintained at 7 dB. The signal input level was 9 mV (open-circuit voltage from a 75Ω source). An assessment of buzz was made in the presence of speech (news reading) modulation on the sound channel.

Table 1 shows subjective grade of annoyance* after adjustment of the bar repetition frequency for a maximum of the buzz effect. The receivers were initially tuned for best picture quality on Test Card C ("normal tuning"), followed by a re-assessment for the maximum and minimum buzz within the range of tuning giving just-acceptable picture quality and sound for ordinary transmissions.

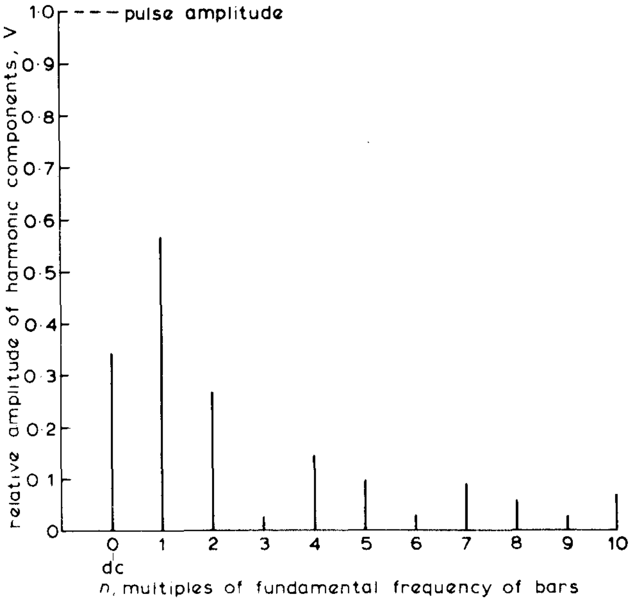

Fig. 2 - Frequency spectrum of infinite train of pulses as produced by the bar pattern

A further test was carried out using a colour transmission, and subjective assessment is given in Table 1 of the visibility of the sound-to-chrominance beat in the "normal tuning" position when receiving standard colour bars.

To assist in the discussion of the results, the overall r.f./i.f. response of each receiver was measured in the same u.h.f. channel as was used in the buzz tests, and with a 9 mV open-circuit input signal. At the same time, the value of the vision carrier i.f. in the "normal tuning" position of each receiver was noted. From these readings, the vision-to-sound carrier attenuation ratio at the detector was evaluated. These figures are given in the final column of Table 1, and it will be observed that a range of values is given for Receiver 4. This tolerance arises because of the somewhat wide variation in the vision carrier i.f. of this receiver for acceptable picture quality.

3.2. Other Causes of Buzz

It may be briefly mentioned here that buzz can also occur through other causes, either independent of picture content (through poor screening, insufficient smoothing or - more commonly - inadequate decoupling of sound circuits from the field time base) or by a.m. break-through when large low-frequency (audio) components exist in the video signal. While in some cases an improvement in the design would be worthwhile, these effects do not

---

* The EBU scale is used, namely 1. Imperceptible, 2. Just perceptible, 3. Definitely perceptible but not disturbing, 4. Somewhat objectionable, 5. Definitely objectionable, 6. Unusable.

TABLE 1

Impairment of Sound Quality with Bar Pattern for Six Receivers

Receiver	Bar freq. MHz	Impairment grade			Visibility of sound-chrominance beat (normal tuning)	Remarks on main sound disturbance	Vision-to-sound carrier attenuation ratio at detector dB
		normal tuning	within possible range of tuning				
			max.	min.			
1.	1·42	5·0	6·0	1·0	1·0	strong buzz	35·5
	1·50	5·0	6·0	1·0		burble and buzz	
	1·17	5·0	6·0	2·0		strong buzz	
Note (b)	1·20	4·5	5·0	1·0		burble	
2.	1·80	5·0	6·0	4·5	1·5	strong buzz	24·9
	1·50	5·0	6·0	2·0		burble	
Note (c)	1·40	4·5	6·0	4·0		buzz	
3.	1·50	3·5	6·0	2·5	1·0	burble	9·8*
Note (a)	1·20	3·0	5·5	2·0		burble	
4.	1·50	3·5	6·0	1·0	2·0	burble and buzz	< 20 to 36
Note (c)	1·00	1·5	-	-		burble	
5.	1·50	3·0	3·0	2·0	2·0	burble	21·2
Note (b)							
6.	1·50	3·0	3·5	1·0	2·5	burble	18·3
Note (b)	1·20	2·0	2·0	1·0		burble	

Notes:

(a) Separate diodes for video and intercarrier signals.

(b) Sound take-off from vision detector.

(c) Sound take-off from video amplifier.

* Measured at intercarrier diode

present a serious problem. One possible cause of buzz arising from low-frequency video components might have been frequency modulation of the vision carrier at the transmitter, but measurements have been made to confirm that this is negligible as a source of audio-frequency f.m. of the intercarrier frequency.

4. DISCUSSION OF TESTS

The results given in Table 1 show that many receivers give an unacceptable level of buzz with certain bar patterns representative of possible programme material such as captions. The variation with tuning adjustment may be quite rapid. This could account for the rather unpredictable nature of the effect under home viewing conditions.

Detailed investigation of the effect of detuning on some of the receivers showed that buzz could often be reduced by detuning in either direction. In one direction, the sound carrier level is enhanced, producing sound-on-vision effects (particularly as a moiré pattern on vertical stripes in the picture); this is a condition that would also give severe sound-to-chrominance beat patterns on a colour transmission. In the other direction, the vision carrier level is increased and the effective depth of modulation and response to upper video frequencies becomes less. In this case the harmonic distortion will generally be lower. The manner in which the buzz changes will depend on the change in the sound carrier level that occurs at the same time, and differs from receiver to receiver. When assessing the grading under "min." in Table 1, tuning positions were allowed in which the picture definition at 3 MHz and above is considerably reduced; when a dramatic decrease in buzz occurred it was always at the expense of a considerable loss of definition.

It was noticed that a severe buzz usually reached a maximum for bar frequencies spaced slightly on either side of a sub-harmonic of 6 MHz; the effect at the sub-harmonic frequency is mainly a "burbling" noise. This is understandable when one considers that for the part of the 50 Hz field period that the bars are not being scanned, the strongest component in the sound i.f. is the wanted

6 MHz signal while, when the bars are being scanned, the strongest component may be the interfering harmonic. If the latter is displaced to one side of 6 MHz (but still within the i.f. and discriminator bandwidth) the discriminator output when presented with these strong components of different frequency will consist of a 50 Hz rectangular wave. When the interfering component is close to 6 MHz, the low-frequency rectangular wave is at a minimum but carrier beat effects (burbling) may be heard. In some receivers the buzz was much stronger on one side of this "beat" condition than on the other; this is what might be expected if the sound circuits had a bandwidth somewhat greater than the minimum required and the alignment was such that 6 MHz did not correspond to the middle of the passband.

Another feature of the tests is that all receivers suffered interference to the sound for a 1·5 MHz bar frequency and, for any given receiver, the effects at this frequency were at least as severe as at any other frequency. A tunable notch filter in the modulated signal chain, when set to attenuate the 3 MHz sideband, was able to remove the buzz. This suggests that the most important mechanism is the production of the 6 MHz second harmonic from the 3 MHz content of the video signal in the receiver. It was pointed out in Research Report No. G-095 that second-harmonic distortion is the principal effect of quadrature distortion at the vision detector and this mechanism would apply to all receivers. Differences in behaviour of receivers regarding other harmonics is probably associated with the contribution of other mechanisms to the total distortion.

One receiver employed two separate detectors to derive the video and the 6 MHz f.m. sound signals (Receiver 3). While better than most receivers, it does not give as good a performance as might have been achieved. The frequency/response characteristic of this receiver measured after the sound-buzz tests, exhibited some peculiar features. The picture quality was also sub-standard, and it may be supposed that a fault condition was operative during the experiment.

Table 1 also shows that there is a correlation between sound disturbance and the vision-to-sound carrier ratio, excessive buzz-on-sound being associated with a low level of sound carrier at the detector. The 3 MHz detail in the picture is produced in bursts at line and field scanning frequencies by the scanning process. The second-harmonic energy will therefore be spread over a bandwidth determined by the duration of the burst. The interference reaching the discriminator in the sound channel will depend on the bandwidth of the sound intercarrier circuits. However, for a bar fundamental frequency of 1·5 MHz produced by the test slide, a simple calculation shows that the second-harmonic energy is spread over a bandwidth of approximately 44 kHz which is easily accommodated in the sound channel. No bandwidth restriction is therefore imposed on the correlation mentioned above for this experiment.

5. CONCLUSIONS

The laboratory experiments have confirmed that many receivers of the type currently in use for BBC-2 reception give an unacceptable level of self-generated interference to the sound channel when certain types of picture modulation are present. This applies even when care is taken to ensure that the depth of modulation does not exceed the specification limit (peak white at 18% of the amplitude during synchronizing pulses).

From the point of view of receiver design, the results of the various laboratory tests have underlined the basic difficulty outlined in Report No. G-095, namely, the conflicting requirements (when the sound take-off point is at or after the vision detector) of avoiding buzz on the one hand and a beat pattern from the sound and chrominance signals on the other. The former requires a high level of sound carrier at the detector, e.g. about 20 dB attenuation of the sound carrier relative to vision carrier attenuation, while the latter requires a low level corresponding to relative attenuation of at least 30 dB. When one further considers the cumulative effect of small disturbances of the vision-to-sound carrier ratio that can arise from the transmitting aerial, propagation effects and the receiver tuner, there is a very strong case for avoiding the use of a common detector (and, necessarily, a common video amplifier) for sound and vision. The use of two detectors together with the appropriate filters - as is current practice in many colour receivers - does permit the two requirements to be met without conflict. Other means of reducing buzz, e.g. reducing the bandwidth of the intercarrier i.f. amplifier to the minimum needed for the system, may be useful but would not alone give the degree of improvement required.

JMP

Printed by BBC Research Department, Kingswood Warren, Tadworth, Surrey